PRICE $3.00

Assembling and Using Your...

Heathkit

CONDENSED

6-METER AMATEUR TRANSCEIVER

MODEL HW-29

HEATH COMPANY

A Subsidiary of Daystrom Inc.

BENTON HARBOR, MICHIGAN

9-320

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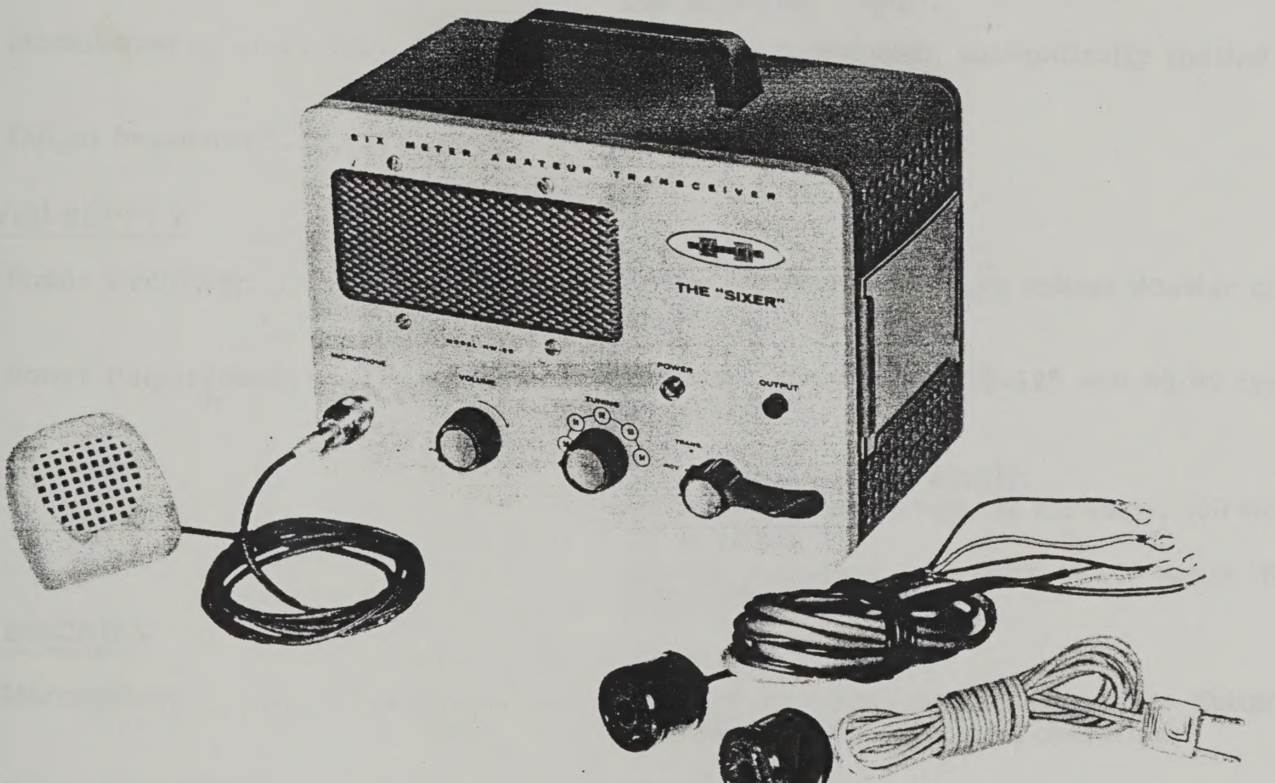
ASSEMBLY AND OPERATION OF THE HEATHKIT 6-METER AMATEUR TRANSCEIVER

MODEL HW-29

"THE SIXER"



SPECIFICATIONS

RECEIVER SECTION

Receiver Type:	Superregenerative detector preceded by RF amplifier stage.
Sensitivity:	Usable with signals as low as 1 microvolt at the antenna terminals.
Speaker Size:	3 1/2" (round).
Audio Power Output:	Approximately 1 watt (undistorted).
Tuning Range:	50-54 mc.

1/22/60

TRANSMITTER SECTION

Power Input to Final RF Amplifier:	Approximately 5 watts.
Frequency Control:	5th overtone quartz crystal. Crystal holder type HC-6/U. Pin spacing - .486". Pin Diameter - .050".
Modulation:	AM plate modulation, automatically limited to not more than 100%.
Output Impedance:	50 or 70 Ω.

POWER SUPPLY

Power Rectifier:	2 silicon diodes in full wave voltage doubler circuit.
Power Requirements:	With built-in supply: 105-125 volt 50/60 cycle AC, 35 watts. With external power supply: 6 volt operation - 6 volts at 1.8 amps, 260 volts DC at 60 ma. 12 volt operation - 12 volts at 0.9 amps, 260 volts at 60 ma.

ACCESSORIES

Microphone:	Ceramic element type, plastic case. Suitable for either hand held or desk operation.
Connecting Cables:	Two supplied, one for 105-125 AC volt operation and one for either 6 or 12 volt external DC power supply use. Power circuits are automatically switched for internal or external power supply use when cables are plugged in.

GENERAL

Tube Complement:	1 - 6AU8 oscillator and RF amplifier. 1 - 6AN8 receiver RF amplifier and detector. 1 - 12AX7 speech amplifier and first audio amplifier. 1 - 6AQ5 audio output and modulator.
Cabinet Dimensions:	8" high (including handle). 6" deep (including knobs). 9 3/4" wide (including license holder).
Net Weight:	6 1/2 lbs.
Shipping Weight:	10 lbs.

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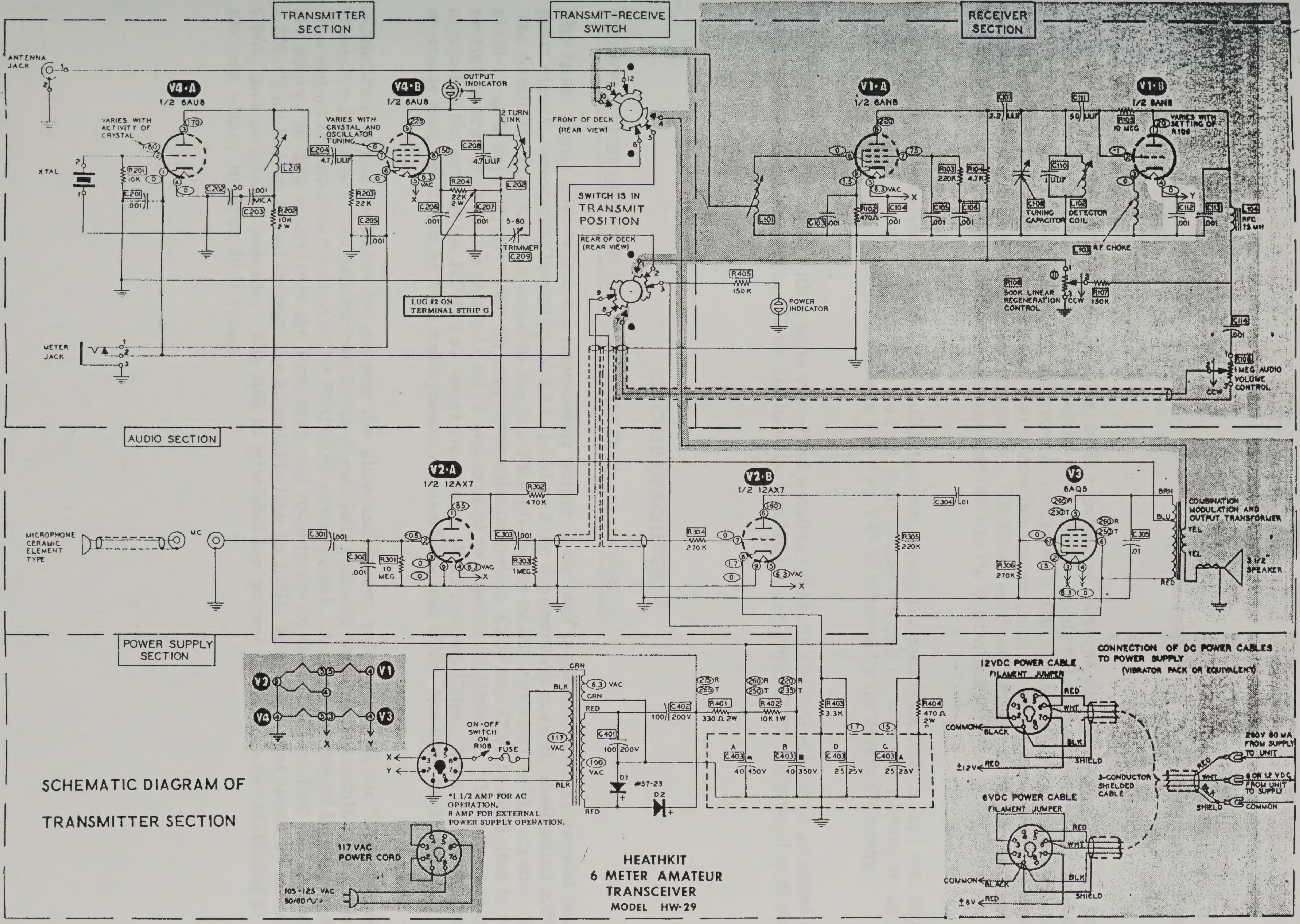


SCHEMATIC DIAGRAM OF TRANSMITTER SECTION

HEATHKIT
6 METER AMATEUR
TRANSCEIVER
MODEL HW-29

INTRODUCTION

The HEATHKIT Model HW-29 Transceiver is a combination transmitter and receiver for use in 6-meter amateur radiotelephone service.

Extensive proofbuilding and field testing over a period of several months have provided conclusive evidence that the HW-29 Transceiver will provide highly reliable service in its intended application if assembled, wired and adjusted in accordance with the instructions contained herein. It is therefore recommended that you follow the instructions carefully and make full use of the Circuit Description, Schematic Diagrams, General Information, etc., in the interest of acquiring a good understanding of this transceiver and its capabilities.

The HW-29 Transceiver has a self-contained power supply for operation from a 117 volt 50/60 cycle AC power line, and can be operated from either a 6 volt or a 12 volt battery by using external power supplies, such as Models VP-6 or VP-12 offered by the Heath Company.

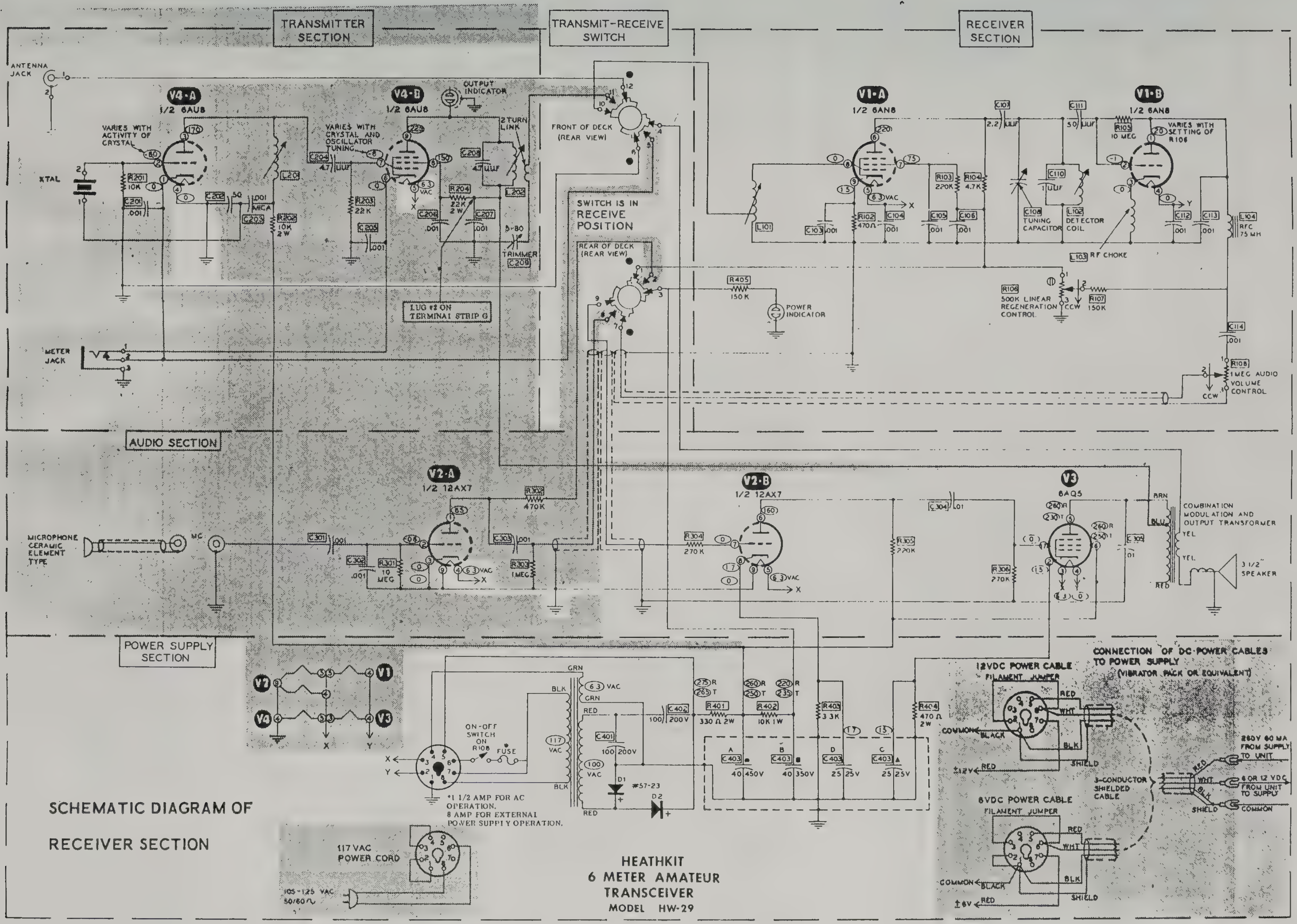
The HW-29 can be used with a wide variety of antenna types; an antenna should be selected for the transceiver on the basis of the application involved. See Page 42 for a discussion of suitable antenna types.

CIRCUIT DESCRIPTION

TRANSMITTER SECTION (See Schematic Diagram on Page 4.)

The basic signal from which the transmitter output is derived is generated in the crystal oscillator circuit, consisting basically of V4A, L201 and the 5th overtone crystal, designated XTAL. The oscillator coil L201 is tuned to the overtone frequency of the crystal in the circuit. The plate-to-grid capacity provided by capacitive voltage divider C202 and C203 is sufficient to feed enough energy back to the grid circuit and crystal to sustain oscillation. This signal is then applied to the grid of the RF final amplifier stage, V4B through C204. This relatively small signal is then amplified by V4B and appears across L202 and C208, the final tank circuit.

Modulation is accomplished by causing the plate and screen voltage source for V4B to vary at the audio frequency rate determined by the signal being passed through the combination modulation-output transformer (see AUDIO SECTION description). A large portion of this modulated RF energy is then taken from the final tank coil inductively by the 1 1/2 turn link coil wound on L202. This energy is fed through the adjustable link on L202, which is series tuned by trimmer C209, and on into the antenna. The link is provided for proper impedance matching to the antenna within its 50 to 70 Ω range.



SCHEMATIC DIAGRAM OF

RECEIVER SECTION

HEATHKIT
6 METER AMATEUR
TRANSCEIVER
MODEL HW-29

RECEIVER SECTION (See Schematic Diagram on Page 6.)

The incoming signal picked up by the antenna is applied to the grid of V1A through the coil tap of L101. Tapped coil L101 forms a broadly tuned circuit which reduces the level of frequencies other than those desired (between 50.0 and 54.0 mc).

The incoming signal, after amplification in V1A, is then applied to the tuned circuit consisting of C108, C110 and L102. C108 is the variable tuning capacitor, and the signal tuned by this circuit is then applied to the grid of the superregenerative detector V1B, through C111.

The superregenerative detector actually goes in and out of oscillation at approximately a 20 kc rate (referred to as "quench" frequency) and the signal detection takes place during the time just before actual oscillation occurs. At this time the gain of V1B is very high, and for this reason, overall sensitivity is quite good. R105 and C111 control the quench frequency rate. L104, in the plate circuit of V1B, presents a high impedance to the quench frequency and a low impedance to audio signal frequencies. C113 bypasses RF present in the detected audio to ground. R106, the REGENERATION control, is used to set the circuit at the maximum sensitivity point by varying the plate voltage.

AUDIO SECTION

In the RECEIVE position, the detected audio signal is applied to the VOLUME control (R108) through C114. Then, a portion of this signal (dependent on the VOLUME control setting) is applied to the grid of V2B through R304. Here the signal is amplified, and this amplified signal is then applied to the grid of V3 through C304. V3 further amplifies the signal and it is then coupled into the speaker by the combination modulation-output transformer.

The operation of the audio section in the TRANSMIT position is very similar, with the following exceptions: The voltage developed by the microphone must be amplified before being applied to V2B, and for this reason, the signal from the microphone passes through V2A. Note that the VOLUME control (R108) is disconnected from the circuit when in the TRANSMIT position. The other exception is that the speaker is disconnected and the audio energy needed to modulate the RF final amplifier stage is taken from a tap on the primary of the combination modulation-output transformer. This tap is so positioned electrically that limiting takes place in V3 before overmodulation can occur.

POWER SUPPLY SECTION

The internal power supply provides the voltages necessary for proper circuit operation from any 105-125 volt 50/60 cycle source. The B+ voltage is produced in a full-wave voltage doubler circuit consisting of D1, D2, C401 and C402. This DC voltage is then filtered by C403A, C403B, R401 and R402, and then distributed to the proper circuit points.

The power connector on the rear chassis apron permits operation from any external source offering the proper voltages. The wiring is so arranged that the tube filaments are connected for either 6 or 12 volt operation, depending upon which power cable is in use.

CONSTRUCTION NOTES

This manual is supplied to assist you in every way to complete your kit with the least possible chance for error. While the arrangement of components and wires shown is probably not the only satisfactory arrangement, nevertheless it is the result of extensive experimentation and trial. If followed carefully, it will result in a stable unit, operating at a high degree of accuracy and dependability. We suggest that you retain the manual in your files for future reference, both in the use of the Transceiver and for its maintenance.

UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. In so doing, you will become acquainted with the parts. Refer to the charts and other information shown on the inside covers of your manual to help you identify the components. If some shortage or parts damage is found in checking the Parts List, please read the REPLACEMENT section and supply the information called for therein, and include all inspection slips in your letter to us. Hardware items are counted by weight and there may be a few more or less than the quantity specified. If a few are missing, please obtain them locally if at all possible.

In order to expedite delivery to you, we are occasionally forced to make minor substitution of parts. Such substitutions are carefully checked before they are approved and parts supplied will work satisfactorily. In checking the Parts List for resistors, for example, you may find that a resistor with a 5% tolerance has been substituted for a resistor with a 10% tolerance, as shown on the Parts List. These changes are self-evident and are mentioned here only to prevent confusion in checking the contents of your kit.

Resistors generally have a tolerance rating of 10% unless otherwise stated in the Parts List. Tolerances on capacitors are generally even greater. Limits of +100% and -50% are common for electrolytic capacitors.

PARTS LIST

PART No.	PARTS Per Kit	DESCRIPTION
Resistors		
1-6	1	470 Ω (yellow-violet-brown) 1/2 watt
1-14	1	3.3 KΩ (orange-orange-red) 1/2 watt
1-16	1	4.7 KΩ (yellow-violet-red) 1/2 watt
1-20	1	10 KΩ (brown-black-orange) 1/2 watt
1-22	1	22 KΩ (red-red-orange) 1/2 watt
1-27	2	150 KΩ (brown-green-yellow) 1/2 watt
1-29	2	220 KΩ (red-red-yellow) 1/2 watt
1-30	2	270 KΩ (red-violet-yellow) 1/2 watt
1-33	1	470 KΩ (yellow-violet-yellow) 1/2 watt
1-35	1	1 megohm (brown-black-green) 1/2 watt
1-40	2	10 megohm (brown-black-blue) 1/2 watt
1A-9	1	10 KΩ 1 watt (brown-black-orange)
1B-3	1	10 KΩ 2 watt (brown-black-orange)
1B-11	1	22 KΩ 2 watt (red-red-orange)
1B-12	1	470 Ω 2 watt (yellow-violet-brown)
1B-16	1	330 Ω 2 watt (orange-orange-brown)
Capacitors		
20-33	1	.001 μfd ±20% mica
20-97	2	50 μμf 5% silver mica
21-14	14	.001 μfd 20% disc ceramic
21-29	2	4.7 μμf 10% tubular ceramic
23-41	2	.01 μfd 600 V paper tubular
25-57	2	100 μfd 200 V tubular electrolytic
25-86	1	40-40-25-25 μfd at 450-350-25-25 V twist prong electrolytic
26-65	1	2.5 μμf variable tuning
28-1	1	2.2 μμf 10% tubular phenolic (red-red-white)
28-2	1	1.0 μμf tubular phenolic (brown-black-white)
31-20	1	5-80 μμf mica trimmer w/mounting foot

SEE FOLD-IN FOR ILLUSTRATION OF PARTS.

PART No.	PARTS Per Kit	DESCRIPTION
Transformers-Coils		
51-43	1	Combination modulation and output transformer
54-87	1	Power transformer
141-6	1	Coil set, consisting of:

40-304	1	Oscillator coil
40-305	1	RF tank coil
40-306	1	RF input coil
40-307	1	Detector coil
45-36	1	RF choke
45-48	1	RF choke

PART No.	PARTS Per Kit	DESCRIPTION
Terminal Strips-Sockets-Plugs		
431-2	3	2-lug terminal strip (no ground)
431-10	2	3-lug terminal strip (center ground)
431-12	1	4-lug terminal strip (1 ground)
431-40	2	4-lug terminal strip (1 ground)
432-1	1	Microphone connector (cable)
432-3	1	Microphone connector (chassis)
434-4	2	Octal socket
434-15	1	7-pin miniature wafer socket
434-42	1	Phono socket
434-74	1	Crystal socket, ceramic
434-75	1	9-pin ceramic socket
434-77	2	9-pin miniature wafer socket w/center ground
435-1	1	Octal socket ring
436-4	1	Phone jack
438-3	1	Phone plug
438-4	2	Phono plug
438-22	1	Octal plug
Controls-Switches		
10-60	1	500 KΩ linear tab mounting control
19-27	1	1 megohm audio taper control w/SPST switch
63-210	1	3-position, 4-circuit transmit-receive switch
Diodes-Tubes-Lamps		
57-23	2	Silicon diode
411-26	1	12AX7 tube
411-60	1	6AQ5 tube
411-68	1	6AN8 tube
411-114	1	6AU8 tube
412-1	1	#47 pilot lamp
412-12	1	Neon pilot lamp (clear)
412-13	1	Neon pilot lamp (red)
Metal Parts		
90-111	1	Cabinet
209-25	1	Speaker grille
200-M219F297	1	Chassis
203-M181F328	1	Front panel
205-M167F	1	Speaker baffle plate

SEE FOLD-IN FOR ILLUSTRATION OF PARTS.

PART No.	PARTS Per Kit	DESCRIPTION
Wire		
340-3	1	Length #16 bare wire
340-8	1	Length #22 bare wire
343-3	1	Length shielded lead
344-1	1	Length #22 hookup wire
344-2	1	Length #18 stranded wire, black
344-3	1	Length #18 stranded wire, red
346-1	1	Length #15 sleeving
347-9	1	Length 3-conductor shielded cable
Hardware		
250-3	3	4-40 x 3/16" RHMS
250-29	1	6-32 x 3/4" RHMS
250-49	8	3-48 x 1/4" BHMS
250-56	13	6-32 x 1/4" BHMS
250-83	2	#10 x 1/2" self-tapping screw
250-89	12	6-32 x 3/8" BHMS
250-133	1	3-48 x 7/16" BHMS
252-1	9	3-48 nut
252-3	22	6-32 nut
252-7	3	3/8-32 control nut
252-22	4	#6 speednut
252-23	1	6-32 knurled thumb nut
252-32	2	Speednut for pilot lamp
253-10	4	3/8" x 5/8" control flat washer
253-21	6	5/32" x 9/16" flat washer
254-1	29	#6 lockwasher
254-4	4	3/8" control lockwasher
254-7	12	#3 lockwasher
254-9	3	#4 lockwasher
259-1	3	#6 solder lug
259-11	3	#6 spade terminal
Miscellaneous		
73-1	3	3/8" rubber grommet
89-1	1	Line cord
211-16	1	Plastic handle
261-1	4	Rubber foot
391-5	1	HEATHKIT logotype
401-21	1	Speaker
421-1	2	1 1/2 amp 3 AG fuse (1 spare)
421-4	2	8 amp fuse (1 spare)
423-1	1	Fuse holder
440-1	2	Octal plug cap
446-M17	1	Plastic window
462-85	2	Knob w/gold insert and indicator dot
462-86	1	Knob lever type w/gold insert and indicator line
480-8	1	Microphone
481-1	1	4-prong capacitor mounting wafer
595-318	1	Construction manual

SEE FOLD-IN FOR ILLUSTRATION OF PARTS.

Since no crystal is supplied with this unit, we list below information necessary to secure appropriate crystals for desired operating frequencies.

1. - Frequency . . . . 50-54 mc
2. - Crystal Holder . . . . Military type HC-6/U
3. - Pin Spacing . . . . . . .486"
4. - Pin Diameter . . . . . .050"
5. - Crystal Type . . . . . 5th overtone

It is recommended the kit builder obtain one or more crystals now so he will be in position to properly test and adjust this unit when completed.

STEP-BY-STEP PROCEDURE

The following instructions are presented in a logical step-by-step sequence to enable you to complete your kit with the least possible confusion. Be sure to read each step all the way through before beginning. When the step is completed, check it off in the space provided. This is particularly important as it may prevent errors or omissions, especially if your work is interrupted.

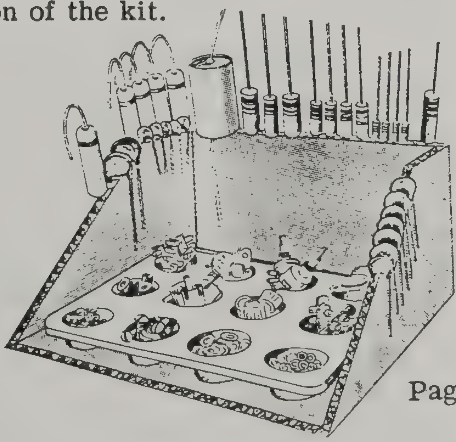
You will notice that the construction has been broken up into several short segments. Try to finish the segment you are working on before stopping. It might be wise to check the next segment before beginning construction of that segment to make sure you will be able to finish before your work is interrupted.

Work slowly and carefully and the completed unit will be a fine piece of equipment which you will be proud to use and display.

We suggest that you do the following before work is started.

1. Attach the large fold-in pictorials to the wall above your work bench.
2. Read several steps ahead of the actual step being performed. This will familiarize you with the relationship of the subsequent operations.
3. Lay out all parts so that they are readily available.
4. Provide yourself with good quality tools. Basic tool requirements consist of a screwdriver with a 1/4" blade; a small screwdriver with a 1/8" blade; long-nose pliers; wire cutters, preferably separate diagonal cutters; a pen knife or a tool for stripping insulation from wires; a soldering iron (or gun) and rosin core solder. A set of nut drivers and a nut starter, while not necessary, will aid extensively in construction of the kit.

Most kit builders find it helpful to separate the various parts into convenient categories. Muffin tins or molded egg cartons make convenient trays for small parts. Resistors and capacitors may be placed with their lead ends inserted in the edge of a piece of corrugated cardboard until they are needed. Values can be written on the cardboard next to each component. The illustration shows one method that may be used.



( ) Pull the slack out of the shield braid pigtails and cut them to the same length as the black leads at both ends of the cable.

( ) Refer to Figure 5 and at the 3" stripped end of the cable install a spade terminal on the red and white leads. Install both the black lead and the shield pigtail to the remaining spade terminal in similar manner.

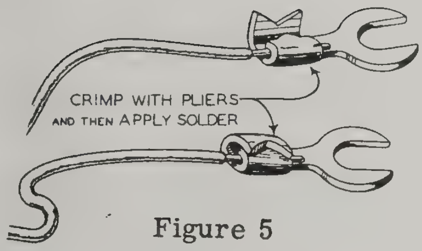


Figure 5

( ) Feed the other end of the cable through the octal plug cap from the grommet side.

( ) Strip the heavy red and black leads 5/8" on one end and 1/4" on the other. Tin the leads. The ends stripped 1/4" are used in the following steps. The ends stripped 5/8" are for connection to the power source.

( ) Connect the heavy red lead to lug 7 of the #434-4 octal socket (S-1).

( ) Connect the small red lead from the shielded cable to pin 5 of the socket (S-1).

( ) Connect the white lead to pin 6 (NS).

( ) Connect both black leads and the shield pigtail to lug 1 (NS).

NOTE: Determine the voltage on which this cable is to operate. If the source is 12 volts, use the first group of steps; if the source is 6 volts, use the second group of steps following this note.

CONNECTIONS FOR 12 VOLT OPERATION

Refer to Figure 3A.

( ) Solder the shield and two black leads, previously connected, to lug 1 (S-3).

( ) Connect a bare wire from lug 6 (S-2) directly across the socket to lug 2 (S-1). Use sleeving.

CONNECTIONS FOR 6 VOLT OPERATION

Refer to Figure 3B.

( ) Connect a bare wire from lug 1 (S-4) to lug 2 (S-1).

( ) Connect a bare wire from lug 6 (S-2) directly across the socket to lug 3 (S-1). Use sleeving.

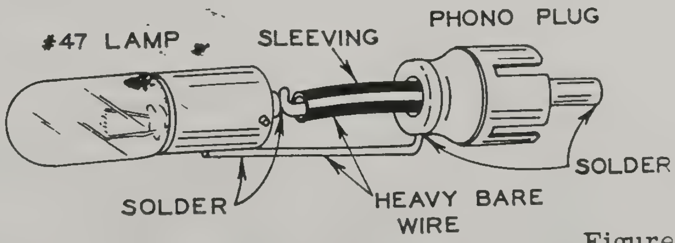
Check the connections just completed on the socket and when you are sure no shorts exist, snap the cap over the socket (if in doubt, tape connections). It might be wise to put a piece of tape on the outside of the shell with the operating voltage of the cable plainly marked for future reference.

DUMMY LOAD

( ) Construct the dummy load by carefully following Figure 6.

NOTE: Use care in soldering to the solder blob at the tip of the #47 lamp to avoid damaging the lamp.

DUMMY LOAD CONSTRUCTION



Figure

It might be wise to now recheck the HW-29 wiring once more against the Pictorials to be sure that everything is correct. Shake out any wire clippings or solder splashes which might be in the chassis. Now proceed with the test and calibration of the unit, as stated in the following pages of the manual.

INITIAL TEST AND CALIBRATION

This and the following section are concerned with adjustments and tests which should be performed before your HW-29 is put into use.

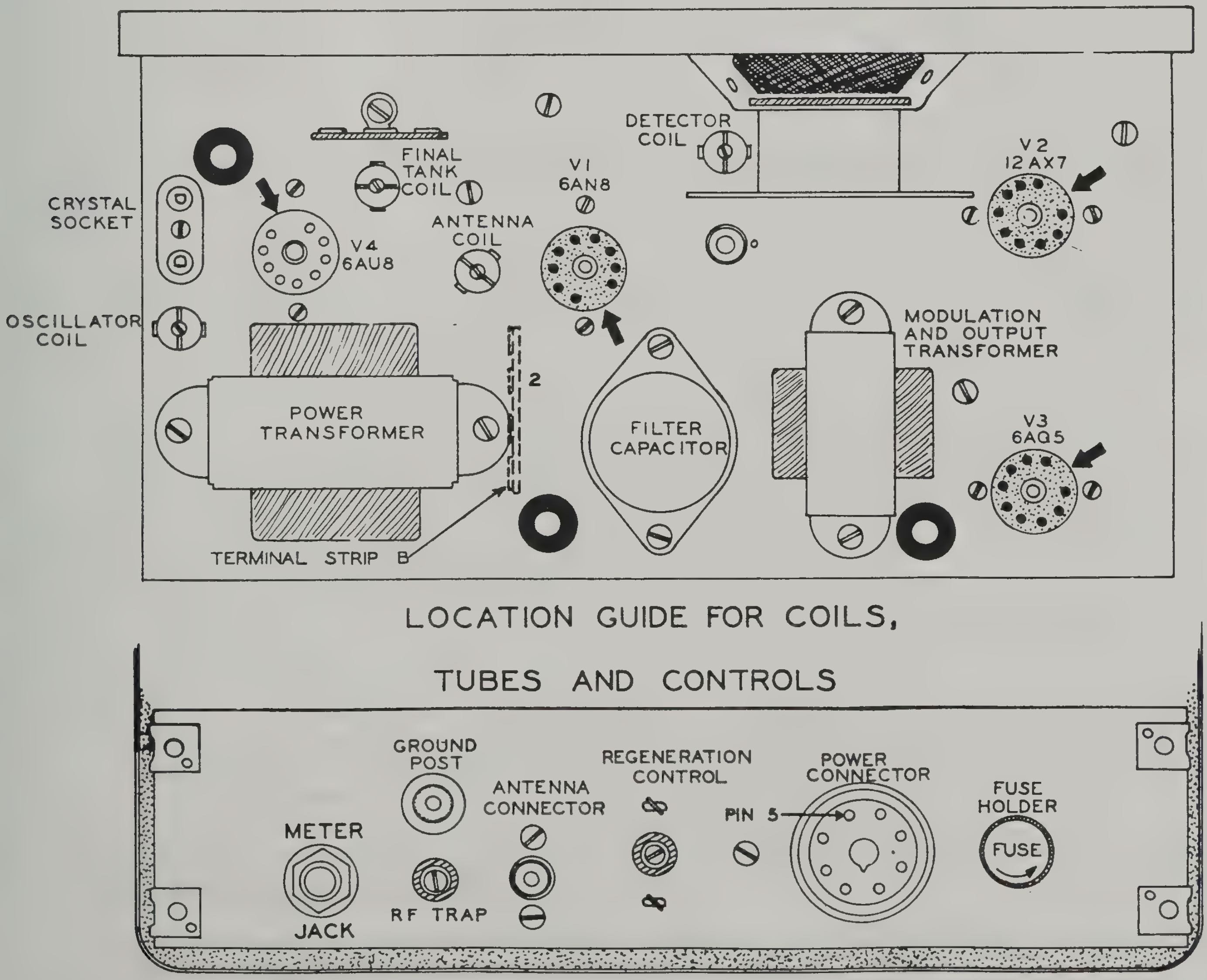
IT SHOULD BE NOTED HERE THAT AN AMATEUR RADIO OPERATOR AND STATION LICENSE OF PROPER GRADE IS REQUIRED TO PLACE THIS TRANSCEIVER ON THE AIR. Information regarding licensing and amateur frequency allocations may be obtained from publications of the Federal Communications Commission or the American Radio Relay League.

RECEIVER AND AUDIO SECTIONS

( ) Begin by checking the power supply for short circuits. An ohmmeter, with positive probe on pin 5 on the power connector and negative probe on the chassis, should read 240 KΩ or above, within one minute after allowing the filter capacitors to charge.

( ) The power supply output voltage will be checked next. Install one of the 1 1/2 ampere fuses and connect the 117 V power cord to the power connector. Plug the cord into a source of 105-125 V 50/60 cycle AC only, and turn the power switch ON. Measure the DC voltage developed between lug 2 on terminal strip B and ground. This voltage should be between 290 and 320 V DC. After making this measurement, check the clear neon "power" lamp for illumination to determine its proper functioning, then turn the unit OFF.

( ) Now install tubes V1 (6AN8), V2 (12AX7) and V3 (6AQ5). See Figure 7.



LOCATION GUIDE FOR COILS, TUBES AND CONTROLS

Figure 7

( ) Set the TRANSMIT-RECEIVE switch to the RECEIVE position, tuning to 50 mc.

( ) Rotate the REGENERATION control on the rear chassis apron full counterclockwise.

( ) Turn the unit on and advance the VOLUME control until the knob pointer is vertical.

( ) Now, slowly advance the REGENERATION control clockwise until a "hissing" or "rushing" sound is heard in the speaker. The correct setting will be approximately 15° beyond the point where the noise becomes audible and is evidenced by a relatively uniform level of background noise over the entire receiver tuning range.

( ) If the above steps have all produced the desired effects, turn the transceiver OFF and go on to the following section. If any difficulty was encountered in the foregoing tests, refer to the IN CASE OF DIFFICULTY section on Page 44.

TRANSMITTER SECTION

( ) Install tube V4 (6AU8) and the crystal. Plug the dummy load into the antenna connector on the rear chassis apron. Loosen the adjustable ANT. TRIMMER adjustment marked "RF TRAP" approximately two turns from the "snugly closed" position.

( ) Set the TRANSMIT-RECEIVE switch to the TRANSMIT position, and rotate the oscillator coil slug until the screw extends approximately 3/8" above the top of the coil form. Rotate the final tank coil slug until the screw extends approximately 3/8" above the coil form. Turn the transceiver ON and, after allowing a half minute or so for warmup, slowly turn the oscillator coil adjustment screw outward (counterclockwise) and observe the dummy load lamp. It may glow with some setting of the oscillator coil slug, indicating operation of the oscillator. If the dummy load does not glow, turn the final tank coil adjustment screw counterclockwise one turn, return the oscillator coil slug to the 3/8" setting and repeat the step. Continue this process until the dummy load lamp glows.

NOTE: As an alternate method of oscillator coil adjustment, a VTVM with RF probe, may be connected between V4, pin 7 and the chassis. As the oscillator slug is adjusted the meter will abruptly give an indication of 4-5 volts negative, indicating that the oscillator is functioning.

( ) The RF final tank coil will be adjusted next, by observing the dummy load lamp as the coil slug is adjusted. Tune for maximum dummy load lamp brilliance. NOTE: It will be impossible to perform this step unless the previous step regarding oscillator coil adjustment has been successful. If difficulty is encountered in this step, it is suggested that you go back and recheck the preceding step.

( ) Next, slowly turn the crystal oscillator slug clockwise (into the coil) until the dummy load lamp goes out. Then slowly turn the slug back out of the coil (counterclockwise) and at the same time repeatedly switch between TRANSMIT and RECEIVE until the lamp comes on each time the switch is thrown into TRANSMIT. Repeat this step until you are sure the slug is just at the point which permits the oscillator to oscillate. Then turn the slug out of the coil (CCW) an additional half turn. At this setting the dummy load lamp should light each time the unit is switched to TRANSMIT.

( ) Recheck the adjustment of the final tank coil tuning slug by adjusting it for maximum brilliance of the dummy load lamp bulb, with the transmitter section operating. Only a slight adjustment should be required.

( ) Connect the microphone to the connector on the front panel. With the transmitter section operating, both the dummy load lamp bulb and the neon OUTPUT indicator on the front panel should increase in brilliance as you speak into the microphone. After completion of this test, disconnect the microphone, and switch the unit to RECEIVE.

NOTE: Changing antennas may call for readjustment of both oscillator and final tank coil slugs.

INITIAL RECEIVER CALIBRATION

( ) Switch the unit OFF and insert the phone plug into the METER JACK on the rear chassis apron. Do not make any connections to the phone plug at this time.

( ) Now, temporarily connect a short length of hookup wire between V4, pin 1 and the ground post on the rear chassis apron.

( ) Turn the unit ON, and set the TUNING knob to the approximate position for your crystal frequency. Adjust the VOLUME control until the background "hiss" is audible and slowly adjust the receiver detector coil through its range until a definite "quiet spot" or absence of background noise is located. Leave the coil set to this spot. After completion of this test, turn the unit OFF, and remove the jumper wire and phone plug.

NOTE: Receiver adjustments inherently interact with each other, therefore receiver calibration should be rechecked after adjustment of the regeneration control and/or RF stage coil slug. It should also be pointed out that in receiver adjustments any tendency toward the appearance of multiple tuning points at any frequency within the tuning range of the receiver is a definite indication that the regeneration control is not sufficiently advanced in the clockwise direction. Speaking generally, if the regeneration control is set at the end of the tuning range where the background "hiss" is lowest, such "multiple tuning" will not be encountered and the noise level will be reasonably uniform over the entire tuning range.

If an accurate frequency standard is available, the 50 mc band edge may be set at the approximate center of the 50 mc marker; the upper band edge should then fall within the 54 mc marker.

( ) If all the adjustments and tests made thus far have been successful, go on with the final adjustments to follow. If difficulty has been encountered, refer to the IN CASE OF DIFFICULTY section, as before.

FINAL TEST AND ADJUSTMENT

NOTE: Due to the circuitry used to permit operation from 6 or 12 volt power sources, under NO circumstances can this unit be operated on external 12 volt DC power supplies with one or more tubes removed. Failure to heed this warning will result in one or more burned out tubes.

TRANSMITTER SECTION

( ) Connect the unit to the power source to be used (either 105-125 V 50/60 cycle AC or a vibrator pack type supply) using the appropriate power cord.

NOTE: The fuse size will have to be increased if a vibrator or similar type supply is used. An 8 ampere fuse is supplied with your kit for this purpose. The supply should have a nominal DC output voltage or 260 V at 60 ma current drain. The HEATHKIT vibrator power supplies meet this requirement.

If an external power supply is to be used, connect the external power supply cable to the power supply as follows:

( ) Connect the BLACK lead and shield to the ground or common terminal.

( ) Connect the RED lead to the B+ output terminal.

( ) Connect the WHITE lead to the terminal marked "A" input, BATT (battery), etc.

Connect the heavy RED and BLACK leads to the power source as follows:

( ) Connect the heavy BLACK lead to a convenient COMMON point of the power system. The chassis or any well grounded part of a car or truck is good. Use the COMMON power connection in a boat or other installation.

( ) Connect the heavy RED lead to the "HOT" side of the power system. It might be wise to connect it to a point that is switched by the ignition switch in a vehicle or boat to avoid running the battery down if the power switch of the HW-29 is accidentally left on when you finish using the mobile unit.

NOTE: In most cases, power source polarity will not be important but this is dependent upon the power supply used. A transistorized power supply is critical on this point. In a supply using a synchronous vibrator, be sure the unit is correctly connected for the polarity employed. The most common type of vibrator supply, that using a non-synchronous vibrator, usually works properly with either polarity.

( ) Turn the unit ON, plug in the dummy load and switch to TRANSMIT. Now measure the DC voltage present at lug 2 on terminal strip G with respect to ground (between 210 V and 250 V). Carefully record this reading for future use. If you are using a vibrator pack power supply, be sure the engine is running at a fast idle during this test, as the battery voltage will vary with engine speed. (The previous statement applies only to those applications where a generator is used to keep the storage battery charged.)

( ) Turn the unit OFF and insert the phone plug into the METER JACK on the rear chassis apron. Refer to Figure 8 and connect a DC milliammeter capable of reading 30 ma (milliamperes) DC to the phone plug. Short lengths of hookup wire may be used, if your meter has no leads.

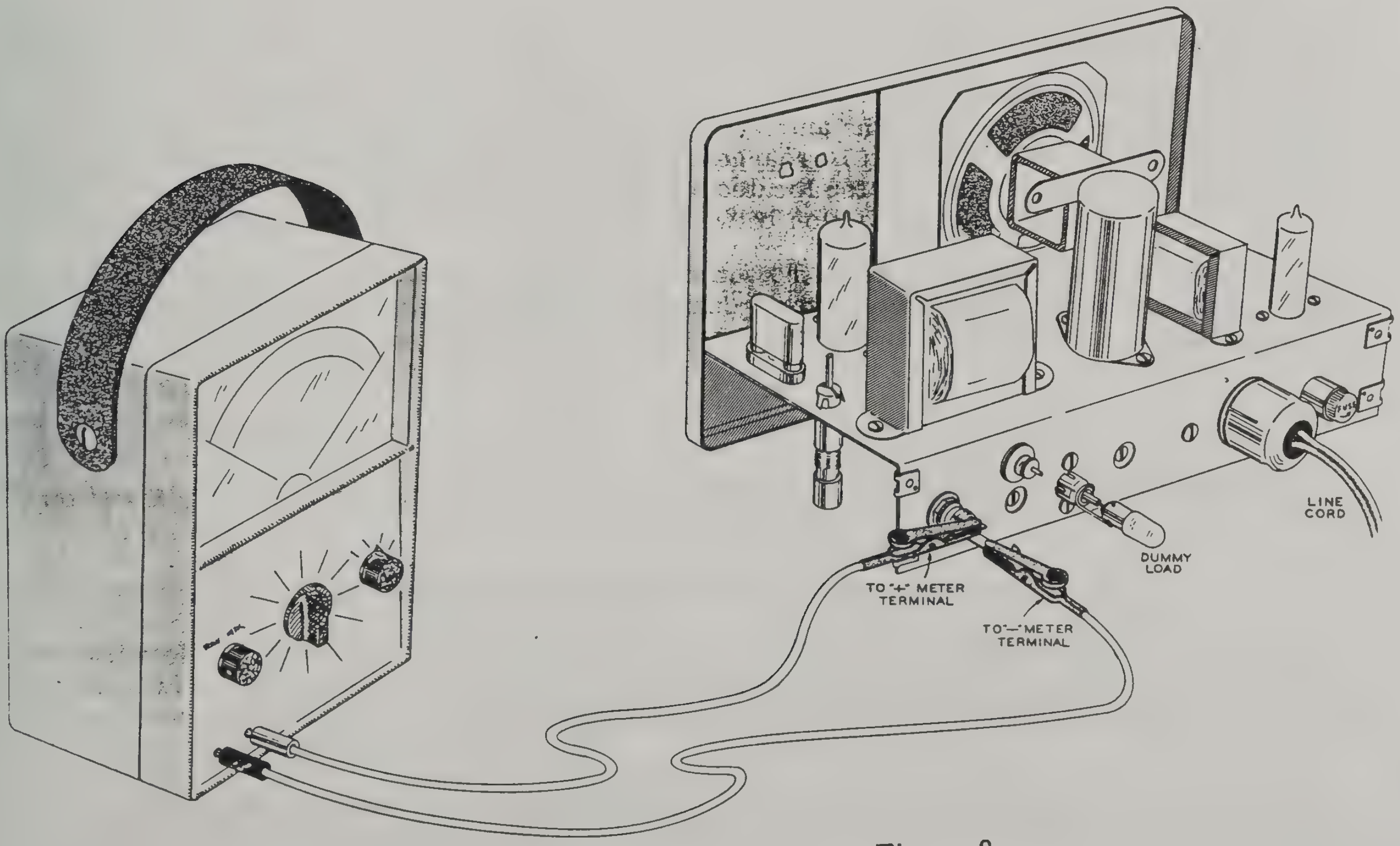


Figure 8

( ) Switch the unit to the TRANSMIT position and turn the power switch ON. As the unit warms up, the current meter reading will slowly climb and should stop in the vicinity of 16-22 ma. Record this reading also, and turn the unit OFF. Now remove the phone plug.

( ) The input power to the final RF amplifier will be calculated next. NOTE that this measurement and calculation includes the total plate and screen power input to the RF amplifier stage, including that dissipated in the screen dropping resistor. The formula for calculating the input power in watts is:

(volts) x I (milliamperes) x 0.001 (conversion factor milliamperes to amperes) = W (watts)

To apply this formula, it is only necessary to multiply the voltage previously recorded by the current recorded in the preceding step. For example, a typical unit might check out as follows: Voltage at terminal strip G, lug 2, 230 volts; current measured at the METER JACK, 20 ma. When these figures are multiplied together, the product multiplied by 0.001 will be the input power to the final amplifier in watts. Substituting the values obtained above in the formula, we have:

$$230 \text{ volts} \times 20 \text{ milliamperes} \times 0.001 = \underline{4.600 \text{ watts}}$$

Solution:

$$\begin{array}{lrl} & 230 & \text{volts} \\ \text{x} & 20 & \text{milliamperes} \\ \hline & 4600 & \\ \text{x} & 0.001 & \\ \hline & \boxed{4.600 \text{ watts}} & \end{array}$$

If the power obtained is over 5 watts or less than 3.5 watts, turn the unit OFF and refer to the IN CASE OF DIFFICULTY section.

ANTENNA TRIMMER ADJUSTMENT

The ANTENNA TRIMMER (TR) located on the rear apron (marked "RF TRAP") is provided to allow proper coupling between the final RF amplifier tank coil link and the antenna to be used.

A simple method involves the use of a tuning meter loosely coupled to the antenna which indicates maximum RF energy delivered to the antenna. The antenna trimmer should be rotated in either direction until maximum indication is reached. This point should be near a decrease in brilliance of the red neon output indicator located on the front panel. The final coil slug may be readjusted to compensate for interaction between the two coil windings.

If an RF tuning meter is not available, the dummy load may again be used for this check and the antenna trimmer set at a point of maximum dummy load lamp brilliance, just short of the point where the red neon output indicator decreases in brilliance. Changing antennas may call for readjustment of this circuit.

RECEIVER SECTION

( ) Connect the unit to the antenna you plan to use (see Page 43), switch to RECEIVE and turn the unit ON.

( ) Loosely couple an RF signal to the antenna or tune in a weak signal.

NOTE: A weak signal is preferred for this adjustment to assure proper tuning. Note that the adjustment will be quite broad, and the peak may not seem very pronounced. However, the proper tuning point will be evidenced by a reduction in the overall background noise, and an improvement in the signal-to-noise ratio.

( ) Carefully tune the receiver antenna coil for best reception. (In experimental units the coil tuning shaft extends about 7/16" out of the form at a frequency of 50.5 mc. This information is given as a reference point only.)

( ) The receiver dial calibration may be rechecked at this time.

( ) Your HW-29 is now ready for installation in the cabinet. Slip the cabinet into place and secure with four 6-32 x 3/8" BHMS.

NOTE: The small card holder on the side of the cabinet may be used to display your license or a copy thereof if you prefer. It may also be used to display an identification card showing ownership and operating frequency, your station call, etc.

( ) Slip the license or card into the holder.

( ) Slip the clear plastic protective window over the license and slightly bend the upper corners of the frame to secure.

GENERAL

1. After becoming familiar with the overall operation of the receiver section of your HW-29, it is suggested that you experiment with the REGENERATION control setting. Although this control is not especially critical as to its setting, there is a setting at which the receiver will operate with maximum sensitivity and the best signal-to-noise ratio. This setting is best found experimentally by utilizing the type of signals normally received. Adjust the control while tuned in on a fairly weak station, and listen to the background noise. The proper setting will be the one at which the lowest background noise is heard. Do not expect the noise to disappear completely, and also note that some shift in receiver calibration may occur as the result of REGENERATION control adjustment. Also, note that some hiss should be heard at all positions of the tuning control with the antenna disconnected. As stated previously, a good indication of proper REGENERATION control adjustment is an essentially uniform hiss level across the entire tuning range.

2. It is suggested that you occasionally check the final RF amplifier stage plate current to be sure that the plate dissipation is normal. The procedure is simple; the cabinet need not be removed unless the plate current (measured at the METER JACK MJ) has increased over that originally recorded at the time of initial check and calibration. The plate voltage in this type of circuit will normally be quite constant, and any changes due to component aging, etc., would tend to reduce, rather than raise, the plate voltage. For this reason, unless the plate current has increased, it will be unnecessary to open the unit to measure the plate voltage. Use the procedure outlined under FINAL TEST AND ADJUSTMENT on Page 38.

INSTALLATION AT A FIXED LOCATION

Various factors should be considered before your HW-29 is installed at a fixed station. Several of these factors are listed below.

Choose an antenna type suitable for the type of performance your situation requires. For short range communication (1-3 miles), one of the small, relatively inexpensive base loaded type antennas should suffice. For greater, more reliable coverage, an antenna of the "ground plane" type is a good choice. Also, the matters of directivity and polarization in your antenna installation should be considered. Both types of antennas described thus far are essentially non-directional and are vertically polarized. A non-directional antenna system is ideal for applications involving fixed-to-mobile unit operation where the mobile units' locations are not predictable.

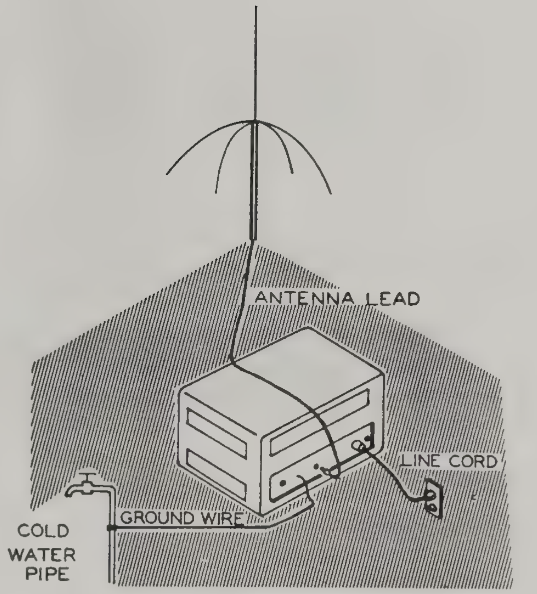


Figure 9

For point-to-point communication over an unusually long range or under adverse operating conditions, a directional "beam" type of antenna may be the solution. This type of antenna is more efficient and usually somewhat more expensive than the types previously discussed, and may also be somewhat more difficult to install. However, it does not lend itself to applications where several mobile units in different locations are to be contacted, due to its relatively high directional characteristics.

In general, a high antenna location is always preferable. For this reason it is strongly recommended that you locate your antenna, regardless of the type chosen, as high as possible.

Be sure the location chosen for the Transceiver is favorable to your antenna location. Avoid excessively long antenna lead-in lengths, if at all possible. However, lengths up to 100 feet or so may be advantageous if they permit a better antenna location.

Try to locate your HW-29 near a good earth ground, such as a water pipe going directly underground. Although the use of an earth ground is not essential for proper operation of your HW-29, in some instances improved performance will result, and it is considered good practice to have the system grounded.

INSTALLATION AT A MOBILE LOCATION

The section to follow will deal specifically with installation in an automobile or light truck, but the majority of this information is also applicable to other mobile installations (boats, etc.). See Figures 10A and 10B.

In a mobile installation, the antenna system chosen is of great importance. Any mobile system is at a decided disadvantage, due to the lack of a good earth ground, the only ground being the capacitive coupling between the vehicle body and the earth below.

With few exceptions, the antenna best suited for mobile service will be either some sort of vertically polarized whip antenna or the current "halo" antenna for horizontal polarization. It is suggested that you contact hams in your area to determine the type of polarization used in your locality since some areas prefer one over the other and it becomes very difficult to maintain communications under cross-polarization conditions at this frequency. The "shortened" or base loaded type whip antenna will normally suffice for short range (1-3 mile) communication. Greater range and more reliable operation can be obtained through the use of a full length one-quarter wave whip antenna. Both of these antenna types use the metal vehicle body as their "ground plane" and for this reason are normally somewhat directional when installed in any practical location, such as the rear of the vehicle. No specific information about the actual directional characteristics of any given installation can be given here due to variables in antenna location, but a typical installation might be expected to yield a radiation pattern similar to that shown in Figure 11.

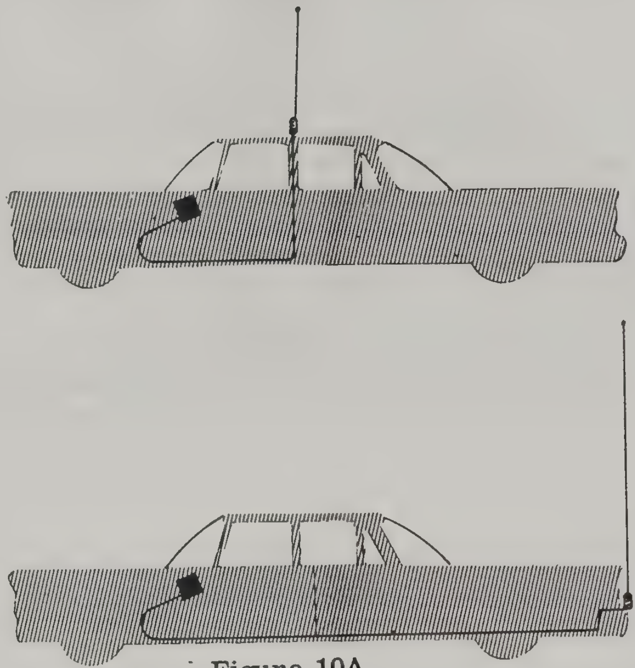


Figure 10A

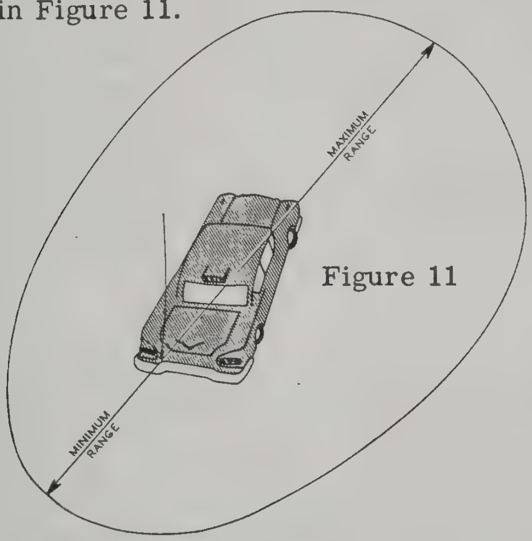


Figure 11

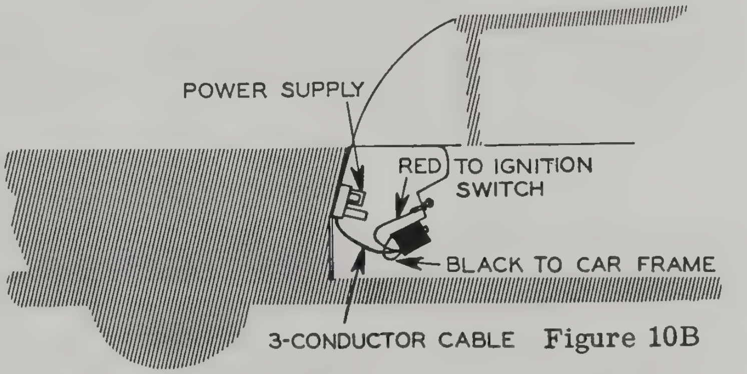


Figure 10B

This directional characteristic normally causes no serious difficulty, but you should be aware of its existence.

In nearly all mobile installations, the ambient noise level will be higher than at a fixed location. For this reason, serious consideration should be given to the physical position of the unit with respect to the operator. Obviously, only those locations within easy reach of the operator should be considered, but usually in any given situation more than one such location exists. Try to pick the location which offers the best compromise of these requirements.

After this location has been chosen, the unit should be securely fastened to some solid surface. Simple sheet metal brackets, fashioned to fit your particular requirements, should suffice.

Engine ignition interference may be a problem, but this is usually relatively easy to correct. Actual field tests in a variety of vehicles have indicated no suppression is required (in the average vehicle) beyond that normally provided for a vehicle with a "factory equipped" standard broadcast band radio receiver. If an ignition interference problem is present nearly any radio service shop, skilled in auto radio repair, should be able to help you locate and correct the difficulty. One possible cause of such interference can be the exhaust system. The muffler and tail pipe are frequently mounted with rubber insulated mounting clamps to reduce vibration, and thus the

muffler and tail pipe are electrically grounded at the engine end only. This problem is more likely to be present if a bumper mount type antenna is employed, and can usually be solved by electrically grounding the tail pipe to the vehicle frame at one or more points. Many other possibilities could be mentioned here, but the many variables between vehicles and installations make this somewhat impractical.

Generator interference may also be a problem as evidenced by a generator "whine". It is recommended in these cases a coaxial capacitor of .5 μfd value with a current rating exceeding the generator output (similar to Sprague 48P18 rated at 40 amperes) be used to replace the usual bypass capacitor. The insertion of a coaxial capacitor in the armature winding lead will require a short additional connecting lead of #10 gauge wire. The capacitor case is grounded using the same screw which held the old capacitor in place. If generator "whine" still persists, it may become necessary to place an RF trap in series with the armature lead in addition to the coaxial capacitor. For frequencies near 50 to 54 megacycles, such a trap may be constructed of approximately five turns of #10 enameled wire, space wound to 1 1/2" in length, on a 1" diameter form with a 3-30 $\mu\mu$f trimmer capacitor in parallel. The trimmer capacitor can then be adjusted for minimum generator "whine". For further information refer to BIBLIOGRAPHY.

BIBLIOGRAPHY

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Lee Aurick, W2QEX, Article, November 1959, CQ, Cowan Publishing Corp., New York, N. Y.

American Radio Relay League RADIO AMATEUR'S HANDBOOK (American Radio Relay League, West Hartford, Connecticut).

American Radio Relay League ANTENNA BOOK (American Radio Relay League, West Hartford, Connecticut).

Editors and Engineers RADIO HANDBOOK (Editors and Engineers, Summerland, California).

Electric Auto-Lite Co., Toledo, Ohio (bulletin #M1544) Suppressed Ignition for Two Way Radio Installations.

IN CASE OF DIFFICULTY

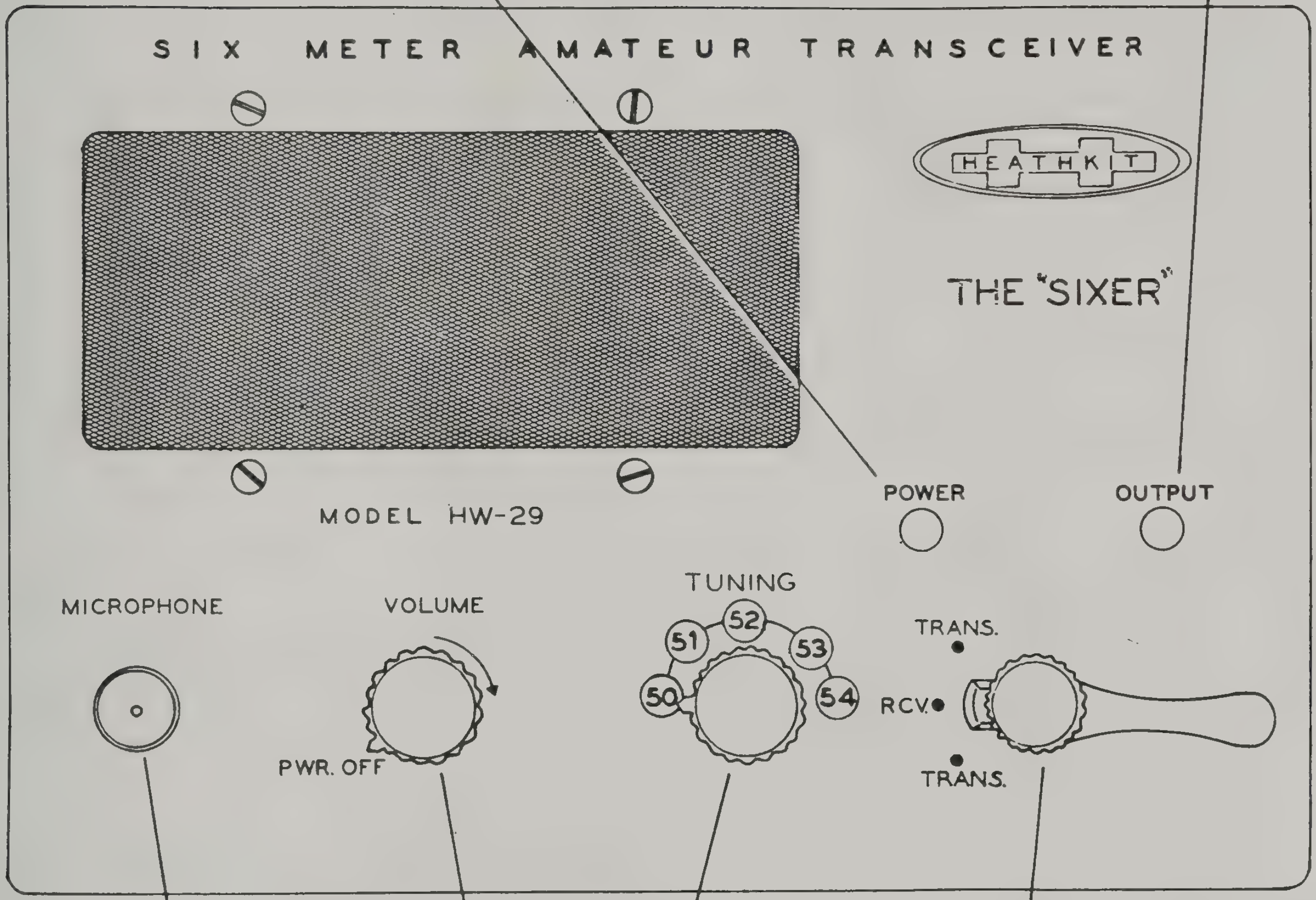
1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.
2. It is interesting to note that about 90% of the kits that are returned for repair are defective due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as illustrated in the Figures found in the SOLDERING TECHNIQUES section of this manual.
3. Check tube locations to be sure that all tubes are in their proper locations. Make sure that all tubes light up properly and test OK in a reliable tube checker.
4. Check the values of the component parts. Be sure that the proper parts have been wired into the circuit, as shown in the Pictorial Diagram and as called out in the wiring instructions.
5. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring beneath the chassis.
6. If, after careful checks, the trouble is still not located and a voltmeter is available, check voltage readings against those found on the Schematic Diagram.
7. A review of the circuit description and associated schematic diagrams will prove helpful in indicating where to look for trouble.
8. Listed on the following page are some possible difficulties which might arise in the construction and operation of your HW-29 Transceiver. The suggested corrective measures given definitely DO NOT RULE OUT all other possibilities, but are given primarily to direct your attention to the areas most likely to be faulty.

DIFFICULTY	POSSIBLE CAUSE AND CORRECTION
Receiver section dead.	a. Faulty tubes - check V1, V2 and V3 voltages. b. Wiring error - recheck wiring. c. Faulty speaker - check speaker voice coil.
Receiver section weak.	a. Faulty tube - check V1 voltages. b. Regeneration control misadjusted. c. RF or detector coils mistuned. d. Faulty antenna or connecting cable.
3. Transmitter appears dead.	a. Faulty tube - check V4 voltages. b. Wiring error - recheck wiring. c. Oscillator and final tank coil mistuned - recheck tuning. d. Dummy load shorted or open - recheck. e. Antenna mismatch - recheck oscillator and final tank coil tuning. f. Mistuned ANT. TRIMMER (marked RF trap) - recheck.
4. Power input to final amplifier too high (over 5 watts), or too low (less than 3.5 watts).	a. Faulty tube - check V4 voltages. b. Wiring error - recheck wiring. c. Oscillator and/or final tank coil mistuned - recheck tuning. d. Faulty meters - recheck meter readings. e. High or low activity crystal - substitute another crystal for comparison check. f. B+ voltage too high or low - check power supply voltages. Check for leaky capacitors or open or shorted resistors at the power supply. Check transformer voltages.
5. Strong signal carrier from Transmitter but no modulation.	a. Faulty microphone or connections - recheck. b. Faulty tubes - check V2 and V3 voltages. c. Wiring error - recheck V2 and V3 wiring.
6. Weak transmitted signal.	a. Faulty antenna - check. b. Shorted or open connecting cable - check. c. Poor antenna location.
7. Interference consistently encountered either during transmission or reception.	a. Change transmitting frequency to more advantageous location in band - check for a frequency with minimum interference.
8. Low power supply voltages.	a. Low line voltage - check. b. Leaky filter capacitors - check. c. Error in dropping resistor values or wiring - check. d. Faulty transformer - check voltages.
9. Modulation hum.	a. Power supply filter capacitor ground connection ungrounded - resolder. b. Faulty tubes - check V2 and V3. c. Open grid circuit connection - check wiring and soldering to V2 and V3.

CONTROL FUNCTIONS

Power Indicator. Informs the operator when power is applied to the unit.

Output Indicator. Informs the operator that the unit is on transmit by indicating the presence of RF in the transmitter section. Also gives an indication that the speech amplifier and modulator circuitry is operating properly by "flickering" or changing in intensity as the operator speaks into the microphone.

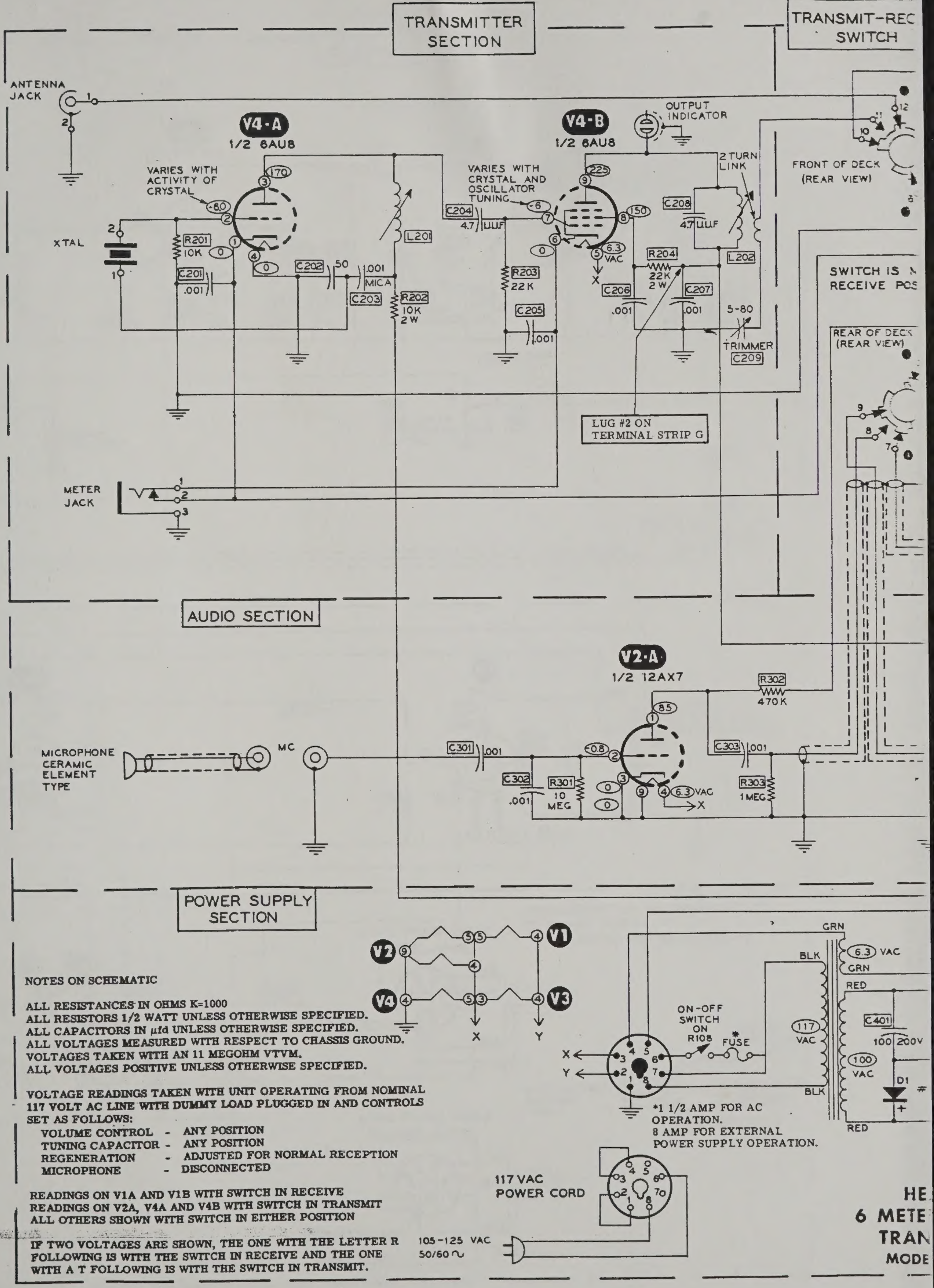


Microphone Connector. The electrical connections between the microphone and unit are made via this connector, to permit removal of the microphone as desired.

VOLUME Control. Permits varying the sound output from the speaker to suit your individual desire. A switch at the counterclockwise end of rotation disconnects the unit from its power source.

TUNING Control. Permits the receiver to be tuned at will. Note that this control has NO effect on transmitter frequency.

TRANSMIT-RECEIVE Switch. The middle, or RECEIVE position actuates the receiver section of the HW-29. Pushing the knob down permits short transmissions of an intermittent nature, and is comparable to a similar function provided in many intercoms. Lifting up allows continuous transmission for longer periods of time without continuous pressure. This position would normally be used primarily for mobile operation. Both TRANSMIT positions perform the same functions electrically.



NOTES ON SCHEMATIC

ALL RESISTANCES IN OHMS K=1000
ALL RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED.
ALL CAPACITORS IN μfd UNLESS OTHERWISE SPECIFIED.
ALL VOLTAGES MEASURED WITH RESPECT TO CHASSIS GROUND.
VOLTAGES TAKEN WITH AN 11 MEGOHM VTVM.
ALL VOLTAGES POSITIVE UNLESS OTHERWISE SPECIFIED.

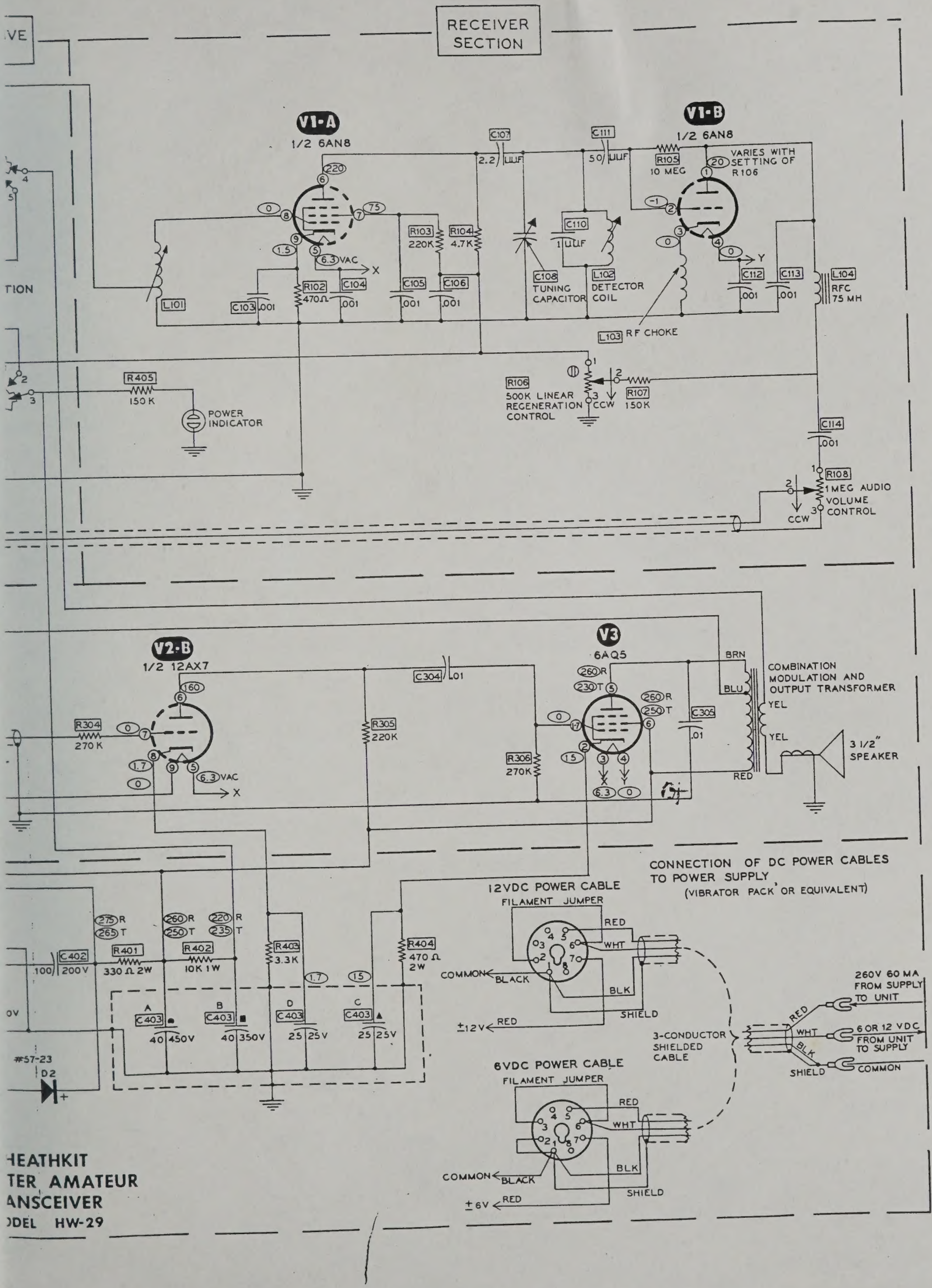
VOLTAGE READINGS TAKEN WITH UNIT OPERATING FROM NOMINAL 117 VOLT AC LINE WITH DUMMY LOAD PLUGGED IN AND CONTROLS SET AS FOLLOWS:

VOLUME CONTROL	- ANY POSITION
TUNING CAPACITOR	- ANY POSITION
REGENERATION	- ADJUSTED FOR NORMAL RECEPTION
MICROPHONE	- DISCONNECTED

READINGS ON V1A AND V1B WITH SWITCH IN RECEIVE
READINGS ON V2A, V4A AND V4B WITH SWITCH IN TRANSMIT
ALL OTHERS SHOWN WITH SWITCH IN EITHER POSITION

IF TWO VOLTAGES ARE SHOWN, THE ONE WITH THE LETTER R FOLLOWING IS WITH THE SWITCH IN RECEIVE AND THE ONE WITH A T FOLLOWING IS WITH THE SWITCH IN TRANSMIT.

*1 1/2 AMP FOR AC OPERATION.
8 AMP FOR EXTERNAL POWER SUPPLY OPERATION.



EATHKIT
TER AMATEUR
ANSCEIVER
DEL HW-29